

EXHIBIT 13

**THE ROLE AND PROCESS OF EXPOSURE ASSESSMENT
REGARDING ASBESTOS-RELATED PERSONAL INJURY LIABILITY:
SUPPLEMENTAL REPORT**

Report Prepared for

W.R. Grace & Co.
5400 Broken Sound Boulevard, N.W.
Boca Raton, FL 33487

by

Peter S.J. Lees, Ph.D., CIH
4415 Underwood Road
Baltimore, MD 21218

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from two main sources. The first source of information, claimants' responses to the *W.R. Grace Asbestos Personal Injury Questionnaire*, was designed to provide information concerning jobs/tasks performed, asbestos-containing products used, and associated use time frames for each individual. Early in this analysis it was recognized that many job titles working with or around a specified product would have exposures that were similar in magnitude. As a result, job titles were, in essence, collapsed into groups having similar exposures based on claimant responses in the "Nature of Exposure" column defined in Part III of the *W.R. Grace Asbestos Personal Injury Questionnaire*:

- A - A worker who personally mixed Grace asbestos-containing products
- B - A worker who personally removed or cut Grace asbestos-containing products
- C - A worker who personally installed Grace asbestos-containing products
- D - A worker at a site where Grace asbestos-containing products were being installed, mixed, removed or cut by others
- E - A worker in a space where Grace asbestos-containing products were being installed, mixed, removed or cut by others
- F - Other

Thus, this report assigns exposures based on these "Nature of Exposure" categories and not on job title *per se*. For the purposes of this report, these groups will be termed "exposure categories." Categories A through C represent direct exposures to airborne fibers, *i.e.*, the exposure resulted from the interaction of that worker with a fiber-containing product, while Categories D and E represent indirect exposures, *i.e.*, the exposure resulted from the interaction of another worker with a fiber-containing product. For the purposes of my analyses, jobs in which the worker might personally disturb a W.R. Grace asbestos-containing product also have been included in Category B. Although not defined explicitly in the questionnaire, it has been assumed that exposures for Category E are those that occur within the area bounded by walls where the work is being done. Category D exposures include those anywhere else on the job site, but outside of the area bounded by walls where the work is being done. As presented in the responses to the questionnaire, Categories D and E do not differentiate between exposures associated with the original installation of a product (*e.g.*, a laborer in the vicinity of the spray application of Monokote 3) and exposures associated with subsequent disturbance of that product (*e.g.*, a laborer in the vicinity of the an electrician installing a single new conduit hanger 20 years after the original installation of the Monokote 3). There are differences in the potential exposures under these two scenarios. For the purposes of this exposure assessment, this sub-category has been split into two separate sections reflecting different exposures.

The second source of information, gathered from historical documents, publications, reports, and other sources, was used to define exposures (*i.e.*, mean airborne asbestos fiber concentrations) associated with those jobs and products identified. These two components were then combined to create a Job Exposure Matrix (JEM) which defines average exposure by product and job. For this report, worker "job" has been replaced by "Nature of Exposure" category derived from the questionnaire. The use of a JEM in the assessment of exposures of this population is an accepted standard technique widely used in published historical exposure reconstruction because it provides structure and consistency of exposure estimates based on known information.⁽¹¹⁻¹⁸⁾ Thus, based on exposure data from a variety of sources and a standardized analytical framework to summarize these data discussed in detail below, all persons claiming exposure in an exposure category and working with the similar products would be assigned the same exposure.

The "vermiculite" product category is composed of four sub-categories: products which were supplied as bags of vermiculite and used dry, represented primarily by masonry fill and attic insulation; products that were supplied as bags of vermiculite and dry-mixed with other substances, represented primarily by horticultural products; products which were supplied as "pre-mixed" bags of vermiculite and other non-asbestiform constituents which were subsequently wet mixed and spray-applied, represented primarily by the post-1973 fireproofing products; and products that were supplied as bags of vermiculite and wet mixed with other substances and troweled, represented primarily by concrete aggregate products.

The "vermiculite and chrysotile" product category is composed of three sub-categories: products which were supplied as "pre-mixed" bags of vermiculite, chrysotile, and other non-asbestiform constituents which were subsequently wet-mixed and spray-applied, represented primarily by the pre-1973 fireproofing products and a number of decorative and acoustic plasters; products which were supplied as "pre-mixed" bags of vermiculite, chrysotile, and other non-asbestiform constituents which were subsequently wet-mixed and trowel-applied, represented primarily by a number of decorative and acoustic plasters and insulating cements; and a third sub-category of these products were supplied in a pre-mixed liquid form which was painted or brushed onto a surface.

The "chrysotile" category is composed of two sub-categories of products which were supplied as "pre-mixed" bags of chrysotile and other non-asbestiform constituents which were subsequently wet-mixed, represented primarily by acoustical and decorative plasters. These products could be spray-applied or troweled. In addition, a third sub-category of these products were supplied in a pre-mixed liquid form which was painted or brushed onto a surface.

The "combined" product category is made up of simultaneous exposures to multiple asbestos-containing products manufactured by W.R. Grace and others during routine building maintenance and renovation activities, but not as part of the original building construction, e.g., electrical work undertaken as a building repair activity.

The "miscellaneous" product category includes mostly very low volume, short-lived products such as gaskets, tiles, sealants, etc. Exposures to these products, if any, would have been transient and insubstantial. They are not addressed in this report. In addition, W.R. Grace manufactured a number of products which did not contain vermiculite or chrysotile asbestos. As no fiber exposures would have resulted from the use of these products, they too are not considered in this report.

Data sources

As stated in my previous report, one of the key challenges to the objective of this exposure evaluation, as opposed to a "generic" exposure assessment, is to specifically identify and estimate the exposures related to W.R. Grace products. In general, the scientific literature relating to worker exposure to asbestos-containing products does not specify the manufacturer of the product. This is a particularly germane problem in the case of W.R. Grace products because they produced many "unique" products, particularly those containing vermiculite. Spray-applied fireproofings provide a pertinent example of the importance of this distinction. As described in my previous report, the composition and methods of preparation and application of the W.R. Grace fireproofing, Monokote 3 produced exposures that were more than an order of magnitude lower than those associated with most of its contemporary competitors.⁽²⁰⁾

Beginning as early as 1968, W.R. Grace undertook a series of field measurements, either through the use of consultants or corporate personnel, to ascertain potential asbestos fiber exposures relating to the use of some of their products under actual use conditions. Because these monitoring data are known to be direct measures of exposure to W.R. Grace products, they represent the data most applicable to the allegations in this case, and thus form the basis of the majority of the exposure estimates used.

W.R. Grace did not measure exposures related to all products or product uses as a part of this monitoring program. To fill in some of the gaps in the W.R. Grace data, analogies have been drawn between a monitored product and a non-monitored product. The basis of these analogies, which are based on professional judgment and conservative assumptions, are presented in appendices to this report. In addition, in some cases published literature was used to fill in missing cells in the JEM. The use of data from this source, however, is limited at this time to post-construction situations in which there are simultaneous exposures to a combination of W.R. Grace products and products manufactured by others. In these instances, since the exposure to the W.R. Grace product constitutes only a part of the total fiber exposure, the exposure concentration reported over-estimates exposure to the W.R. Grace product.

Most of the exposure measurements used as part of this assessment were collected from persons doing their routine job in an actual work environment and are thus assumed to represent a "typical" day of exposure. Exposures associated with simulations of work activities were considered for inclusion but were not the preferred source of information, especially if measurements of actual jobsite exposures existed. While potentially valuable, simulations are, by definition, not reality and thus should not be relied upon unless there is no actual jobsite exposure information available.

Finally, because personal measures of exposure are most representative of actual worker exposures, such measures were the preferred input to exposure estimations. Stationary or area measurements of exposures do not reflect variation in worker exposure due to movement and proximity to the source. Depending on placement of the individual area samplers, they may over- or under-estimate actual worker exposures. For this reason, they were not used unless there were no personal measurements available. In general, personal exposure measures used to estimate exposures for Exposure Categories A, B, and C while area sample measures were more frequently used to estimate exposures in Categories D and E. Generally speaking, these area samples were placed in locations that maximized fiber concentration measurements, e.g., immediately downwind of a source or in close proximity to a source, and thus probably over-estimate personal exposures for these Exposure Categories.

Criteria for inclusion of data/study

Given the multiple sources of data potentially available for summarizing exposures, a set of evaluation criteria were developed to assure that only the highest quality, methodologically reliable data were included in the exposure evaluation. The adequacy and completeness of documentation of the sampling report formed the heart of the evaluation criteria. In general, to be judged adequate for inclusion, measurements had to be collected and analyzed following good industrial hygiene practice using accepted standard methods and, in general, required clear documentation of various standard elements of the exposure measurement data collection process. To be included in the exposure summary, each study was required to meet the

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following criteria:

- Clearly identifiable author/investigator
- Clearly identifiable date
- Clearly identifiable job site/work location
- Clearly identifiable product
 - Manufactured by W.R. Grace if unique
 - Manufactured by others or not identified if W.R. Grace product substantially similar
- Clearly identifiable worker job title/task (translated to nature of exposure category)
- Primary data collection only (no unsubstantiated data summaries)
- Clearly identifiable and recognized standard sampling and analytical methodology
 - accepted standard methods used; method explicitly stated
 - accepted standard methods used; method inferred from description
- 8-hour time weighted average exposure estimates
 - full 8-hour sampling
 - <8-hour sampling with explicit statement about non-sampled period
 - task length sampling with generalized (and documented) task duration
 - <8-hour sampling without explicit statement about non-sampled period assumed to be 8-hour time weighted average (worst-case assumption)
 - unspecified sampling time assumed to be 8-hour time weighted average (worst-case assumption)
- LOD clearly stated for samples in which no fibers were detected on analysis
- Data followed generally accepted expectations; anomalous and substantially inconsistent data excluded, e.g., measured upwind fiber concentrations substantially higher than simultaneous downwind fiber concentrations bring the reliability of data into question; basis for rejection.

Regardless of the source of exposure information, these same evaluation criteria were applied to candidate studies. If any of these criteria are violated, the study is not included in the subsequent summary of exposure concentrations.

Exposure assessment methodology

This section describes the methods used for data evaluation and summary. Data from all of the exposure studies used in this evaluation are presented in Appendices C through L, each representing a separate product and product use category. Data from each step in the evaluation process described below are presented in these appendices.

After accepting each study based on the criteria described above, the specific product monitored was identified and assigned to the appropriate product category. Similarly, the jobs titles and/or tasks performed were identified and assigned to the appropriate exposure category.

Next the individual data were examined. Since 8-hour TWA exposure estimates are the accepted metric of choice for evaluating long-term exposures,⁽¹⁾ such measurements were abstracted if presented or calculated if possible from other data provided. If an 8-hour TWA was not provided or could not be calculated, the reported concentration was assumed to be an 8-hour TWA measure of exposure. This is a very conservative approach to estimating the average 8-hour TWA as it will assign a maximum value, which is almost certainly an over-estimate of actual exposure, to those exposure measurements for which the sampling time is not stated.

Subsequent analyses were, in essence, a data reduction process by which an overall average 8-hour TWA exposure was calculated. This was a multi-step process replicated for each product and product use sub-category and exposure category and is documented in the corresponding Appendices. First, individual 8-hour TWA estimates presented in a study were averaged by job title for each study (see Table 1 in each of the appendices). The average exposure for each job title was then averaged to determine a mean exposure by exposure category for that study (see Table 3 in each of the appendices). The average exposure for each exposure category for each study was then averaged to determine a mean exposure by exposure category all studies (see Table 4 in each of the appendices). The process of averaging within a study and then averaging the mean from each study is a standard statistical method used to prevent bias associated with different sample sizes and essentially weights each study equally to prevent undue influence of a study with a high number of samples. Note that a listing of studies rejected from analysis and the reason for rejection are also presented as Table 2 in each of the appendices.

On microscopic analysis, fibers were reported to be "not detected" in many of the individual samples. In these instances, data were examined to determine the limit of detection (LOD) concentration for that sample. Good industrial hygiene practice dictates that for such samples, the exposure should be reported as a "less than" value representing the highest possible exposure for that sample volume, *i.e.*, $<0.X \text{ f/cm}^3$. In some cases where the LOD value was not explicitly stated, it could be readily calculated from other data provided. It is customary industrial hygiene practice to use the LOD value divided by two or divided by the square root of two to determine an exposure value to be used in calculating a mean exposure.⁽²¹⁾ For the purposes of this evaluation the LOD value divided by two was used to calculate exposure means.

Finally, the use of phase contrast microscopy (PCM) to analyze of the number of fibers collected as a part of exposure monitoring in an environment with mixed asbestiform and non-asbestiform

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fibers is well known to over-estimate actual asbestos fiber concentrations. This is a particular problem for vermiculite-containing products. Several studies^(22,23) have been conducted in which airborne vermiculite samples have been evaluated using both PCM (which counts all fibers meeting specified size criteria) and TEM (which counts only asbestiform fibers meeting these same size criteria). The fiber concentrations resulting from TEM analysis, termed phase contrast microscopy equivalent (PCME), are invariably substantially less than the PCM-based estimate of exposure. Consequently, to better reflect the actual asbestos fiber exposures, reported vermiculite exposure concentrations made with PCM have been adjusted on a preliminary basis using an algorithm derived from plaintiff and defendant analytical data of vermiculite attic insulation exposures (see Appendix M). It is reasonable to assume that a similar adjustment is appropriate for the "vermiculite and chrysotile" and "chrysotile" product categories; efforts are currently underway to develop a similar adjustment factor. As such, the exposure estimates currently presented in these product categories probably represent a substantial overestimation of actual asbestos fiber exposures.

In categories for which there are no monitoring data, exposures were assessed by comparing information on product composition and product use to other categories for which there were data. This approach to estimating unknown exposures is well established in the literature and is recognized as a method of reconstructing historical exposures. The rationale for each analogy used to estimate average exposures is presented in the appendix corresponding to the product and exposure category.

Exposures

Using studies that met acceptance criteria and the methodology described above, mean 8-hour TWA exposures were calculated by exposure and product categories. The details of the calculations are provided for each product type in Appendices C through L; the overall mean exposures for each exposure and product category are summarized in Tables 2 and 3 below.

Preliminary summary data presented in these tables follow the same format for each exposure category. The first column presents the mean fiber exposure as measured by PCM. The second column presents the mean exposure to asbestos fibers using the TEM-derived adjustment factor described above. Note that these values in the "vermiculite" section are based on this formula whereas the values for the other products are expressed as a "less than" value, reflecting the current absence of an adjustment formula for these products. The third column presents the number of samples included in the mean concentration and the fourth column presents the proportion of those samples in which fibers were not detected. Finally, average exposures based on data can be differentiated from average exposures based on analogous products and uses by the presence of a "less than" (<) symbol. Averages based on directly pertinent data are presented as a numerical concentration and have corresponding entries in the "N" and "% <LOD" columns; averages based on an analogous product and use are presented as < the numerical concentration of the analogous product and use category and do not have corresponding entries in the "N" and "% <LOD" columns. Entries preceded by the symbol "<<" indicate that the exposure, while unknown and not based on data, is judged to be very much less than the closest analogous product and use category.

I am continuing to review data relevant to the issues raised in my report and other reports in this case and may supplement this report at a later date.